CHAPTER 13 (Odd)

1. a. $T = 18\text{ ms} - 8\text{ ms} = \mathbf{10\text{ ms}}$

   b. **2 cycles**

   c. $f = \dfrac{1}{T} = \dfrac{1}{10 \times 10^{-3}\text{ s}} = 0.1 \times 10^3\text{ Hz} = \mathbf{100\text{ Hz}}$

   d. Amplitude = **5 V**

   2 ms
   5 V
   x
   6 ms

   $\dfrac{2\text{ ms}}{x} = \dfrac{6\text{ ms}}{5\text{ V}}$

   $x = \dfrac{5}{6}(2\text{ V}) = 1.67\text{ V}$

   $V_{p\text{-}p} = 5\text{ V} + 1.67\text{ V} = \mathbf{6.67\text{ V}}$

3. $T = 26\text{ ms} - 16\text{ ms} = \mathbf{10\text{ ms}}$

   $f = \dfrac{1}{T} = \dfrac{1}{10\text{ ms}} = \mathbf{100\text{ Hz}}$

5. a. $f = \dfrac{1}{T} = \dfrac{1}{1/60\text{ s}} = \mathbf{60\text{ Hz}}$

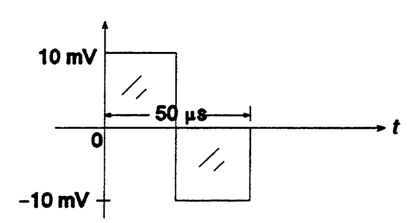
   b. $f = \dfrac{1}{T} = \dfrac{1}{0.01\text{ s}} = \mathbf{100\text{ Hz}}$

   c. $f = \dfrac{1}{34 \times 10^{-3}\text{ s}} = \mathbf{29.41\text{ Hz}}$

   d. $f = \dfrac{1}{25 \times 10^{-6}\text{ s}} = \mathbf{40\text{ kHz}}$

7. $T = \dfrac{1}{20\text{ Hz}} = 0.05\text{ s},\ 5(0.05\text{ s}) = \mathbf{0.25\text{ s}}$

9. $T = \dfrac{1}{20\text{ kHz}} = 50\ \mu\text{s}$



11. a. $(45°)\left[\dfrac{\pi}{180°}\right] = 0.25\pi = \mathbf{\dfrac{\pi}{4}\text{ rad}}$

    b. $(60°)\left[\dfrac{\pi}{180°}\right] = \mathbf{\dfrac{\pi}{3}\text{ rad}}$

    c. $(120°)\left[\dfrac{\pi}{180°}\right] = \mathbf{\dfrac{2}{3}\pi\text{ rad}}$

    d. $(270°)\left[\dfrac{\pi}{180°}\right] = \mathbf{\dfrac{3}{2}\pi\text{ rad}}$

    e. $(178°)\left[\dfrac{\pi}{180°}\right] = \mathbf{0.989\pi\text{ rad}}$

    f. $(221°)\left[\dfrac{\pi}{180°}\right] = \mathbf{1.228\pi\text{ rad}}$

13. a. $\omega = \dfrac{2\pi}{T} = \dfrac{2\pi}{2\text{ s}} = \mathbf{3.14\text{ rad/s}}$

    b. $\omega = \dfrac{2\pi}{0.3 \times 10^{-3}\text{ s}} = \mathbf{20.94 \times 10^3\text{ rad/s}}$

c. $\omega = \dfrac{2\pi}{4 \times 10^{-6}\ \text{s}} = \mathbf{1.57 \times 10^6\ rad/s}$

d. $\omega = \dfrac{2\pi}{1/25\ \text{s}} = \mathbf{157.1\ rad/s}$

15. a. $\omega = 2\pi f = \dfrac{2\pi}{T} \Rightarrow f = \dfrac{\omega}{2\pi}$

$T = \dfrac{2\pi}{\omega} = \dfrac{1}{f}$

$f = \dfrac{\omega}{2\pi} = \dfrac{754\ \text{rad/s}}{2\pi} = \mathbf{120\ Hz},\ T = \mathbf{8.33\ ms}$

b. $f = \dfrac{\omega}{2\pi} = \dfrac{8.4\ \text{rad/s}}{2\pi} = \mathbf{1.34\ Hz},\ T = \mathbf{746.27\ ms}$

c. $f = \dfrac{\omega}{2\pi} = \dfrac{6000\ \text{rad/s}}{2\pi} = \mathbf{954.93\ Hz},\ T = \mathbf{1.05\ ms}$

d. $f = \dfrac{\omega}{2\pi} = \dfrac{1/16\ \text{rad/s}}{2\pi} = \mathbf{9.95 \times 10^{-3}\ Hz},\ T = \mathbf{100.5\ ms}$

17. $(30°)\left[\dfrac{\pi}{180°}\right] = \dfrac{\pi}{6},\ \alpha = \omega t \Rightarrow \omega = \dfrac{\alpha}{t} = \dfrac{\pi/6}{5 \times 10^{-3}\ \text{s}} = \mathbf{104.7\ rad/s}$

23. $i = 0.5 \sin 72° = 0.5(0.9511) = \mathbf{0.4755\ A}$

25. $6 \times 10^{-3} = 30 \times 10^{-3} \sin \alpha$

$0.2 = \sin \alpha$

$\alpha = \sin^{-1} 0.2 = \mathbf{11.537°}$ and $180° - 11.537° = \mathbf{168.463°}$

29. a. v leads i by **10°**

b. i leads v by **70°**

c. i leads v by **80°**

d. i leads v by **150°**

31. a. $\left[\dfrac{\pi}{6}\right]\left[\dfrac{180°}{\pi}\right] = 30°,\ \omega = 2\pi f = 377\ \text{rad/s}$

$\mathbf{v = 25 \sin(\omega t + 30°)}$

b. $\pi - \dfrac{2}{3}\pi = \dfrac{\pi}{3} = 60°,\ \omega = 2\pi f = 6.28 \times 10^3\ \text{rad/s}$

$\mathbf{i = 3 \times 10^{-3} \sin(6.28 \times 10^3 t - 60°)}$

33. $T = \dfrac{1}{f} = \dfrac{1}{1000\ \text{Hz}} = 1\ \text{ms}$

$t_1 = \dfrac{120°}{180°}\left[\dfrac{T}{2}\right] = \dfrac{2}{3}\left[\dfrac{1\ \text{ms}}{2}\right] = \mathbf{\dfrac{1}{3}\ ms}$

35. $\omega = \dfrac{2\pi}{T} \Rightarrow T = \dfrac{2\pi}{\omega} = \dfrac{2\pi}{1800} = 3.49\ \text{ms}$

$t_1 = \dfrac{40°}{180°}\left[\dfrac{T}{2}\right] = 0.222\left[\dfrac{3.49\ \text{ms}}{2}\right] = \mathbf{0.388\ ms}$

37. a. $T = (2\text{ div.})(0.2\text{ ms/div.}) = \mathbf{0.4\text{ ms}}$

b. $f = \frac{1}{T} = \frac{1}{0.4\text{ ms}} = \mathbf{2.5\text{ kHz}}$

c. Average $= (-2.5\text{ div.})(10\text{ mV/div.}) = \mathbf{-25\text{ mV}}$

d. —

39. a. $$G = \frac{\frac{1}{2}(3\text{ s})(10\text{ V}) + \frac{1}{2}(2\text{ s})(10\text{ V}) - \frac{1}{2}(2\text{ s})(10\text{ V})}{8\text{ s}}$$
$$= \frac{15\text{ V} + 10\text{ V} - 10\text{ V}}{8} = \mathbf{1.875\text{ V}}$$

b. $$G = \frac{\frac{1}{2}\left[\frac{\pi}{2}\right](10\text{ mA}) - 2(15\text{ mA}) - \frac{\pi}{2}(5\text{ mA})}{2\pi}$$
$$= \frac{2.5\pi\text{ mA} - 30\text{ mA} - 2.5\pi\text{ mA}}{2\pi}$$
$$= \frac{-30\text{ mA}}{2\pi} = \mathbf{-4.775\text{ mA}}$$

41. a. $T = (4\text{ div.})(10\ \mu\text{s/div.}) = \mathbf{40\ \mu s}$

b. $f = \frac{1}{T} = \frac{1}{40\ \mu\text{s}} = \mathbf{25\text{ kHz}}$

(c) $$G = \frac{(2.5\text{ div.})(1.5\text{ div.}) + (1\text{ div.})(0.5\text{ div.}) + (1\text{ div.})(0.6\text{ div.}) + (2.5\text{ div.})(0.4\text{ div.}) + (1\text{ div.})(1\text{ div.})}{4\text{ div.}}$$
$$= \frac{3.75\text{ div.} + 0.5\text{ div.} + 0.6\text{ div.} + 1\text{ div.} + 1\text{ div.}}{4}$$
$$= \frac{6.85\text{ div.}}{4} = 1.713\text{ div.}$$
$1.713\text{ div.}(10\text{ mV/div.}) = \mathbf{17.13\text{ mV}}$

43. a. $\mathbf{2\sin 377t}$ b. $\mathbf{100\sin 377t}$

c. $\mathbf{84.87 \times 10^{-3}\sin 377t}$ d. $\mathbf{33.95 \times 10^{-6}\sin 377t}$

45. $$V_{\text{eff}} = \sqrt{\frac{(3\text{ V})^2(2\text{ s}) + (2\text{ V})^2(2\text{ s}) + (1\text{ V})^2(2\text{ s}) + (-1\text{ V})^2(2\text{ s}) + (-3\text{ V})^2(2\text{ s}) + (-2\text{ V}^2(2\text{ s})}{12\text{ s}}}$$
$= \mathbf{+2.16\text{ V}}$

47. $$G = \frac{(10\text{ V})(5\ \mu\text{s}) - (10\text{ V})(5\ \mu\text{s}) + 0}{15\ \mu\text{s}} = \frac{0 + 0}{15\ \mu\text{s}} = \mathbf{0\text{ V}}$$
$$V_{\text{eff}} = \sqrt{\frac{(10\text{ V})^2\ 5\ \mu\text{s} + (-10\text{ V})^2\ 5\ \mu\text{s} + 0}{15\ \mu\text{s}}} = \mathbf{8.165\text{ V}}$$

49. a. $T = (4 \text{ div.})(10\ \mu\text{s/div.}) = \mathbf{40\ \mu s}$

$f = \dfrac{1}{T} = \dfrac{1}{40\ \mu\text{s}} = \mathbf{25\ kHz}$

Av. = (1 div.)(20 mV/div.) = **20 mV**

Peak = (2 div.)(20 mV/div.) = 40 mV

$$\text{Effective} = \sqrt{V_0^2 + \frac{V_{max}^2}{2}} = \sqrt{(20\text{ mV})^2 + \frac{(40\text{ mV})^2}{2}} = \mathbf{34.641\ mV}$$

b. $T = (2 \text{ div.})(50\ \mu\text{s}) = \mathbf{100\ \mu s}$

$f = \dfrac{1}{T} = \dfrac{1}{100\ \mu\text{s}} = \mathbf{10\ kHz}$

Av. = (−1.5 div.)(0.2 V/div.) = **−0.3 V**

Peak = (1.5 div.)(0.2 V/div.) = 0.3 V

$$\text{Effective} = \sqrt{V_0^2 + \frac{V_{max}^2}{2}} = \sqrt{(.3\text{ V})^2 + \frac{(.3\text{ V})^2}{2}} = \mathbf{367.42\ mV}$$

CHAPTER 13 (Even)

2. a. $T = 15\ \mu s$

   b. $2\frac{1}{3}$ cycles

   c. $f = \frac{1}{T} = \frac{1}{15\ \mu s} = 66.7\ kHz$

   d. Positive amplitude = **10 V**, $V_{p\text{-}p} = 20\ V$

4. a. $T = \frac{1}{25\ Hz} = 40\ ms$

   b. $T = \frac{1}{35 \times 10^6\ Hz} = 28.57\ ns$

   c. $T = \frac{1}{55 \times 10^3\ Hz} = 18.18\ \mu s$

   d. $T = \frac{1}{1\ Hz} = 1\ s$

6. $T = \frac{24\ ms}{80\ cycles} = 0.3\ ms$

8. $f = \frac{42\ cycles}{6\ s} = 7\ Hz$

10. a. $V_{peak} = (3\ boxes)(50\ mV/box) = 150\ mV$

    b. $T = (4\ boxes)(10\ \mu s/box) = 40\ \mu s$

    c. $f = \frac{1}{T} = \frac{1}{40\ \mu s} = 25\ kHz$

12. a. $\left[\frac{\pi}{4}\right]\left[\frac{180^\circ}{\pi}\right] = 45^\circ$

    b. $\left[\frac{\pi}{6}\right]\left[\frac{180^\circ}{\pi}\right] = 30^\circ$

    c. $\left[\frac{\pi}{10}\right]\left[\frac{180^\circ}{\pi}\right] = 18^\circ$

    d. $\left[\frac{7}{6}\pi\right]\left[\frac{180^\circ}{\pi}\right] = 210^\circ$

    e. $(3\pi)\left[\frac{180^\circ}{\pi}\right] = 540^\circ$

    f. $(0.55\pi)\left[\frac{180^\circ}{\pi}\right] = 99^\circ$

14. a. $\omega = 2\pi f = 2\pi(50\ Hz) = 314.16\ rad/s$

    b. $\omega = 2\pi f = 2\pi(600\ Hz) = 3769.91\ rad/s$

    c. $\omega = 2\pi f = 2\pi(2\ kHz) = 12.56 \times 10^3\ rad/s$

    d. $\omega = 2\pi f = 2\pi(0.004\ MHz) = 25.12 \times 10^3\ rad/s$

16. $(45^\circ)\left[\frac{\pi}{180^\circ}\right] = \frac{\pi}{4}$ radians

    $t = \frac{\theta}{\omega} = \frac{\pi/4\ rad}{2\pi f} = \frac{\pi/4\ rad}{2\pi(60\ Hz)} = \frac{1}{(8)(60)} = \frac{1}{480} = 2.08\ ms$

18. a. Amplitude = 20, $f = \frac{\omega}{2\pi} = \frac{377 \text{ rad/s}}{2\pi}$ = **60 Hz**

b. Amplitude = 5, $f = \frac{\omega}{2\pi} = \frac{754 \text{ rad/s}}{2\pi}$ = **120 Hz**

c. Amplitude = 10^6, $f = \frac{\omega}{2\pi} = \frac{10{,}000 \text{ rad/s}}{2\pi}$ = **1591.55 Hz**

d. Amplitude = 0.001, $f = \frac{\omega}{2\pi} = \frac{942 \text{ rad/s}}{2\pi}$ = **149.92 Hz**

e. Amplitude = 7.6, $f = \frac{\omega}{2\pi} = \frac{43.6 \text{ rad/s}}{2\pi}$ = **6.94 Hz**

f. Amplitude = 1/42, $f = \frac{\omega}{2\pi} = \frac{6.28 \text{ rad/s}}{2\pi}$ = **1 Hz**

22. $T = \frac{2\pi}{\omega} = \frac{2\pi}{157} = 40 \text{ ms}, \frac{1}{2} \text{ cycle} = \mathbf{20 \text{ ms}}$

24. $1.2\pi\left[\frac{180°}{\pi}\right] = 216°$

$v = 20 \sin 216° = 20(-0.588) = \mathbf{-11.76 \text{ V}}$

26. $v = V_m \sin \alpha$

$40 = V_m \sin 30° = V_m(0.5)$

$\therefore V_m = \frac{40}{0.5} = \mathbf{80 \text{ V}}$

$\frac{30°}{360°} = \frac{1 \text{ ms}}{T}$

$T = 1 \text{ ms}\left[\frac{360}{30}\right] = \mathbf{12 \text{ ms}}$

$f = \frac{1}{T} = \frac{1}{12 \times 10^{-3} \text{ s}} = \mathbf{83.33 \text{ Hz}}$

$\omega = 2\pi f = (2\pi)(83.33 \text{ Hz}) = 523.58 \text{ rad/s}$

and $v = \mathbf{80 \sin 523.58}t$

30. a. $v = 2 \sin(\omega t \underbrace{- 30° + 90°}_{+60°})$

$i = 5 \sin(\omega t + 60°)$

} **in phase**

b. $v = \sin(\omega t + 20° + 180°) = \sin(\omega t + 200°)$

$i = 10 \sin(\omega t - 70°)$ } ***i* leads *v* by 90°**

c. $v = 4 \sin(\omega t + 90° + 90° + 180°) = 4 \sin \omega t$

$i = \sin(\omega t + 10° + 180°) = \sin(\omega t + 190°)$ } ***i* leads *v* by 190°**

32. a. $v = 0.01 \sin(2\pi(25)t + 11/18\pi) = \mathbf{0.01 \sin(157t - 110°)}$

b. $i = 2 \times 10^{-3} \sin(2\pi(10 \times 10^3)t + 135°) = \mathbf{2 \times 10^{-3} \sin(62.8 \times 10^3 t + 135°)}$

34. $\omega = 2\pi f = 50{,}000$ rad/s

$$f = \frac{50{,}000}{2\pi} = 7957.75 \text{ Hz}$$

$$T = \frac{1}{f} = 125.66\ \mu\text{s}$$

$$t_1 = \frac{40°}{180°}\left[\frac{T}{2}\right] = 0.222(125.66\ \mu\text{s}) = \mathbf{27.92\ \mu s}$$

36. a. T = (8 div.)(1 ms/div.) = **8 ms** (both waveforms)

b. $f = \dfrac{1}{T} = \dfrac{1}{8 \text{ ms}}$ = **125 Hz** (both)

c. Peak = (2.5 div.)(0.5 V/div.) = 1.25 V
V_{rms} = 0.707(1.25 V) = **0.884 V**

d. Phase shift = 4.6 div., T = 8 div.

$$\theta = \frac{4.6 \text{ div.}}{8 \text{ div.}} \times 360° = \mathbf{207°\ \textit{i}\ leads\ \textit{e}}$$

or ***e* leads *i* by 153°**

38. a. $G = \dfrac{(6\text{ V})(1\text{ s}) + (3\text{ V})(1\text{ s}) - (3\text{ V})(1\text{ s})}{3\text{ s}} = \dfrac{6\text{ V}}{3} = \mathbf{2\ V}$

b. $G = \dfrac{\left[\frac{1}{2}(4\text{ ms})(20\text{ mA})\right] - (2\text{ ms})(8\text{ mA})}{8\text{ ms}} = \dfrac{40\text{ mA} - 16\text{ mA}}{8} = \dfrac{24\text{ mA}}{8} = \mathbf{3\ mA}$

40. b. **0.5 V**

42. a. V_{eff} = 0.707(20 V) = **14.14 V**

b. V_{eff} = 0.707(7.07 V) = **5 V**

c. I_{eff} = 0.707(6 mA) = **4.242 mA**

d. I_{eff} = 0.707(16 mA) = **11.312 mA**

44. $V_{eff} = \sqrt{\dfrac{(2\text{ V})^2(4\text{ s}) + (-2\text{ V})^2(1\text{ s}) + (3\text{ V})^2\left[\frac{1}{2}\text{s}\right]}{12\text{ s}}} = \mathbf{1.43\ V}$

46. $G = \dfrac{(10\text{ V})(4\text{ ms}) - (10\text{ V})(4\text{ ms})}{8\text{ ms}} = \dfrac{0}{8\text{ ms}} = \mathbf{0\ V}$

$V_{eff} = \sqrt{\dfrac{(10\text{ V})^2(4\text{ ms}) + (-10\text{ V})^2(4\text{ ms})}{8\text{ ms}}} = \mathbf{10\ V}$

48. $G = \dfrac{\frac{1}{2}bh}{T} = \dfrac{\frac{1}{2}(10\text{ ms})(20\text{ V})}{10\text{ ms}} = \mathbf{10\ V}$

50. a. $V_{dc} = IR$ = (4 mA)(2 kΩ) = 8 V
Meter indication = 2.22(8 V) = **17.76 V**

b. V_{rms} = 0.707(16 V) = **11.31 V**